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(54) **HEAT EXCHANGER WITH FINNED TUBE AND METHOD OF PRODUCING THE SAME**

(75) Inventor: **Christian Cannas**, Mandello Del Lario (IT)

(73) Assignee: **Elbi International S.p.A.**, Turin (IT)

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F28F 9/22 (2006.01)

(52) **U.S. Cl.** **165/163**; 165/156

(58) **Field of Classification Search** .... 165/163, 165/156, 159, 160, 129, 130; 126/99 C; 122/18.4, 169, 247

See application file for complete search history.

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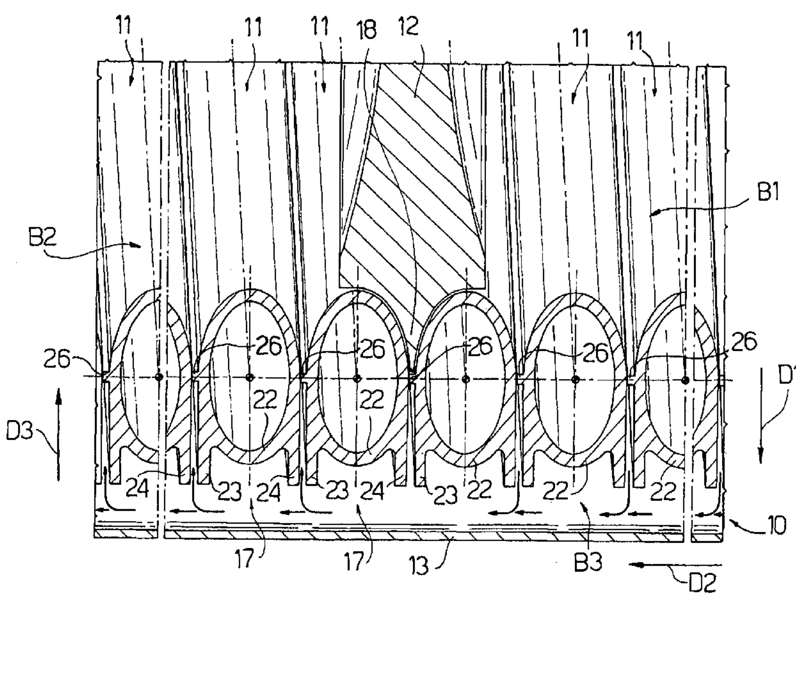
Primary Examiner — Tho V Duong

(74) *Attorney, Agent, or Firm* — Davidson Berquist Jackson & Gowdey, LLP

(57) **ABSTRACT**

A heat exchanger for a gas boiler for producing hot water is provided with a casing extending along a first axis and through which combustion fumes flow; a tube along which water flows, and which is housed inside the casing and coils about the first axis to form a helix made of a succession of turns; and deflecting means for directing the fumes between successive turns; the tube being provided with a first and a second fins, which extend along the length of the tube, face one another, and are tangent to the tube.

15 Claims, 2 Drawing Sheets



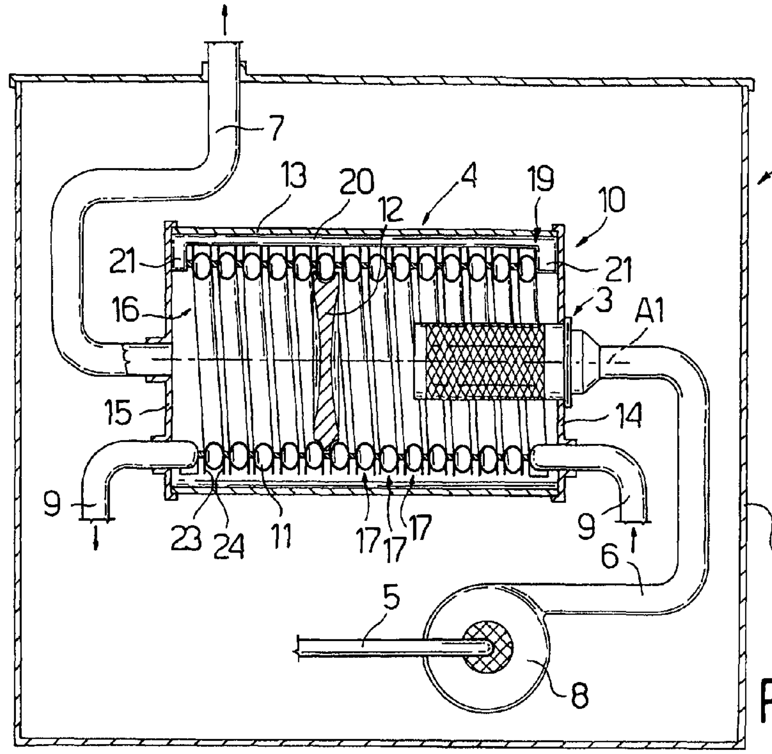


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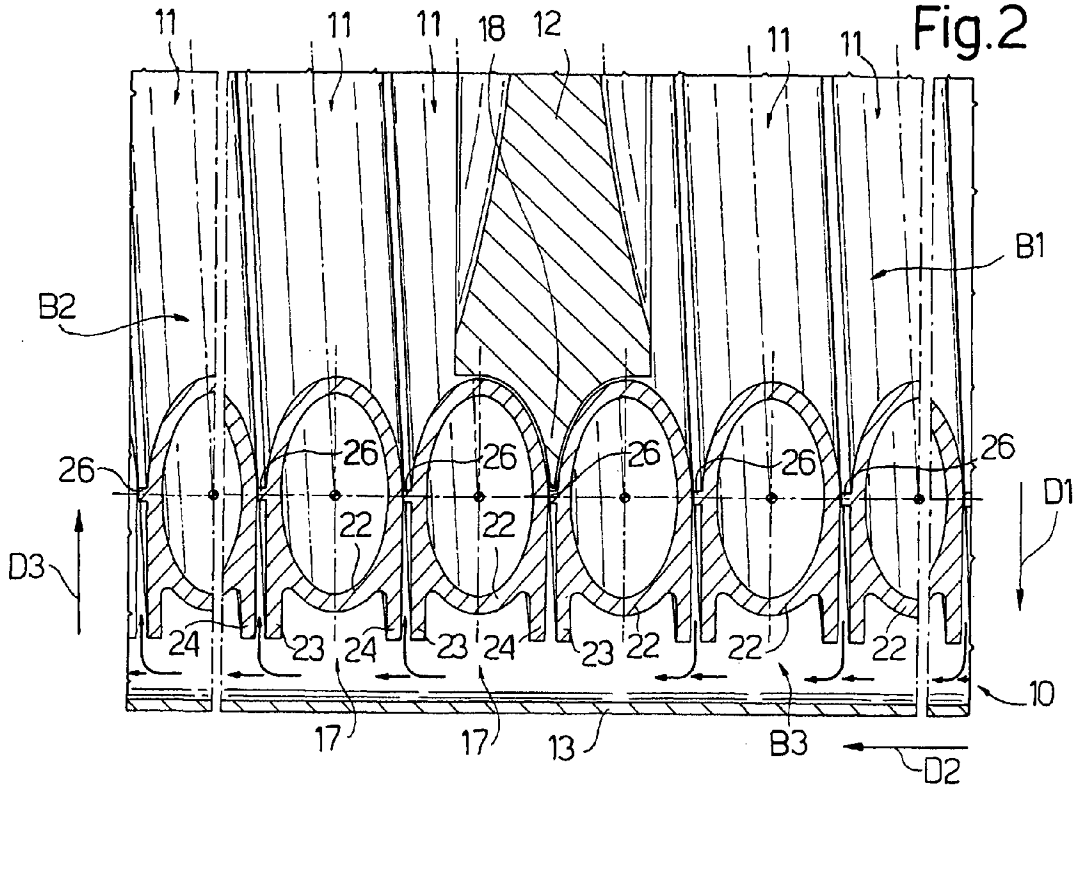
Fig.1

Fig.2



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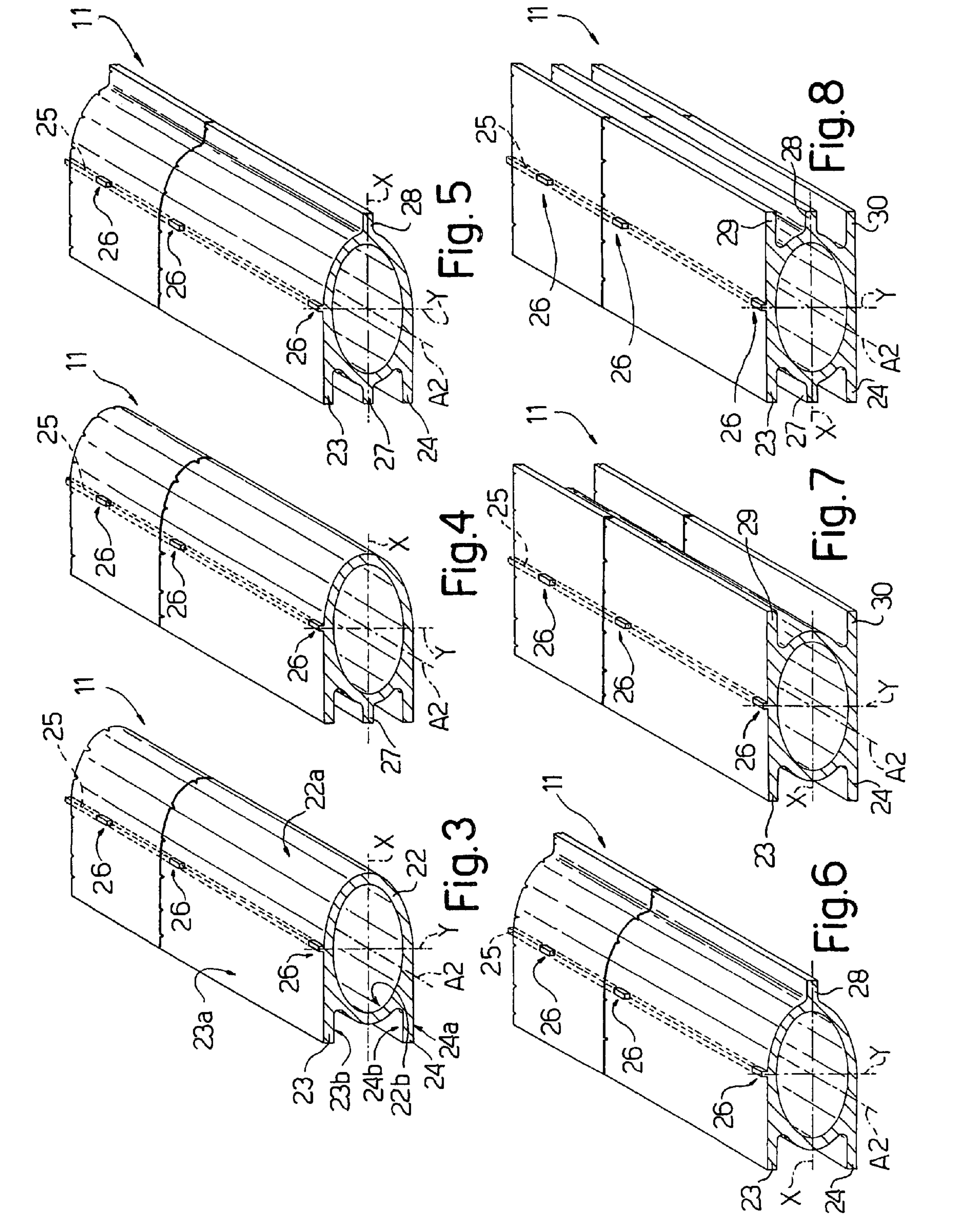

Fig.3

Fig.4

Fig.5

Fig.6

Fig.7

Fig.8

HEAT EXCHANGER WITH FINNED TUBE AND METHOD OF PRODUCING THE SAME

The present invention relates to a heat exchanger with finned tube.

More specifically, the present invention relates to a heat exchanger for a gas boiler for producing hot water.

BACKGROUND OF THE INVENTION

A gas boiler for producing hot water normally comprises a gas burner, and at least one heat exchanger through which combustion fumes and water flow. Some types of gas boilers, known as condensation boilers, condense the steam in the combustion fumes and transfer the latent heat in the fumes to the water. Condensation boilers are further divided into a first type, equipped with a first exchanger close to the burner, and a second exchanger for simply condensing the fumes; and a second type, equipped with only one heat exchanger which provides solely for thermal exchange along a first portion, and for both thermal exchange and fume condensation along a second portion.

A condensation or dual-function exchanger of the above type is disclosed in WO 2004/090434 and comprises a casing extending along a first axis and through which combustion fumes flow; a tube along which water flows, and which is housed inside said casing and coils about the first axis to form a helix comprising a succession of turns; and deflecting means for directing the fumes between successive turns in a first direction perpendicular to said first axis. The tube is finned with at least a first and second outward fins facing one another and extending along the length of the tube.

Even though the above identified heat exchanger proved to be extremely effective in term of heat exchange, has still the drawback that the distance between the first and second outward fins of adjacent turns cannot be freely selected to optimise the heat exchange because the convexity of the tube protruding from the outward fins imposes a limit to such a distance to let the fumes flow with an adequate speed.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a heat exchanger for a gas boiler for producing hot water, which further improves the heat exchange without imposing structural limitation to the design parameters.

According to the present invention, there is provided a heat exchanger characterized in that said first and second fins are tangent to said tube.

In this way, the distance between the fins of adjacent turns can be selected to optimise the heat exchange.

The present invention also relates to a method of producing a heat exchanger.

According to the present invention, there is provided a method of producing a heat exchanger, as claimed in the attached Claims.

BRIEF DESCRIPTION OF THE DRAWINGS

A number of non-limiting embodiments of the present invention will be described by way of example with reference to the accompanying drawings, in which:

FIG. **1** shows a schematic front view, with parts in section and parts removed for clarity, of a gas boiler equipped with a heat exchanger in accordance with the present invention;

FIG. **2** shows a larger-scale section of a detail of the FIG. **1** heat exchanger;

FIG. **3** shows a view in perspective of a tube used to produce the FIG. **1** exchanger;

Figures from **4** to **8** show variations of the tube of FIG. **3**.

DETAILED DESCRIPTION OF THE INVENTION

Number **1** in FIG. **1** indicates as a whole a gas boiler. Boiler **1** is a wall-mounted condensation boiler, i.e. in which the vapour in the combustion fumes is condensed, and comprises an outer structure **2** in which are housed a burner **3**; a heat exchanger **4**; a gas supply conduit **5**; a pipe **6** for supplying an air-gas mixture to burner **3**; a combustion gas exhaust pipe **7**; a fan **8** connected to supply pipe **6**, and which performs the dual function of supplying the air-gas mixture to burner **3**, and expelling the combustion fumes; and a water circuit **9**. Burner **3** is connected to pipe **6**, is cylindrical in shape, and comprises a lateral wall with holes (not shown) for emitting the air-gas mixture and feeding the flame. Burner **3** is partially housed inside exchanger **4** which, in fact, also acts as a combustion chamber. Heat exchanger **4** is substantially cylindrical in shape, extends along a substantially horizontal axis A**1**, and comprises a casing **10**, through which the combustion fumes flow; a finned tube **11**, along which water flows; and a disk **12** for directing the fumes along a given path inside exchanger **4**. Casing **10** comprises a cylindrical lateral wall **13** about axis A**1**; an annular wall **14** connected to lateral wall **13** and to burner **3**; and an annular wall **15** connected to lateral wall **13** and to exhaust pipe **7**. Burner **3** extends, coaxially with exchanger **4**, inside of exchanger **4** for a given length. Tube **11** coils about axis A**1** to form a helix **16** comprising a succession of adjacent turns **17**, each located close to lateral wall **13**, and has two opposite ends with known fittings (not shown) for connecting tube **11** to water circuit **9** outside exchanger **4**. Disk **12** has a lateral helix-shaped edge **18** engaging turns **17**. That is, disk **12** is screwed to turns **17** into the desired position along axis A**1** and in a position substantially perpendicular to axis A**1**. An inwardly finned helix will require a disk with a differently shaped hedge to match with the shape of the fins.

Exchanger **4** comprises three spacers **19** for keeping turns **17** a given distance from lateral wall **13**. Each spacer **19** comprises a straight portion **20** parallel to axis A**1**, and from which project two fingers **21** for clamping the helix **16** on opposite sides. Helix **16**, disk **12**, and spacers **19** define, inside casing **10**, a region B**1** housing burner **3**; a region B**2** communicating directly with, exhaust pipe **7**; and three regions B**3**, each extending between two spacers **19**, turns **17**, and lateral wall **13**. Combustion of the air-gas mixture takes place in region B**1**; and the resulting fumes, being prevented by disk **12** from flowing directly to region B**2**, flow between turns **17**, in a direction D**1** substantially perpendicular to axis A**1**, to regions B**3**, along which they flow in a direction D**2** substantially parallel to axis A**1**. On reaching regions B**3**, the fumes flow between turns **17** in direction D**3** to region B**2** and then along exhaust pipe **7**.

Tube **11** is preferably made of aluminium or aluminium-based alloy. With reference to FIG. **3**, finned tube **11** is an extruded tube, which extends along an axis A**2**, and comprises an oval-section wall **22**; two fins **23** and **24** on one side of tube **11**. The cross section of tube **11** has a major axis X and a minor axis Y. Wall **22** is provided with an outer surface **22***a* and an inner surface **22***b* and has a constant thickness. Fins **23** and **24** are parallel to axis A**2** of tube **14** and to major axis X, and are therefore parallel to one another and face one another. The maximum extension of fins **23** and **24**, in a direction parallel to major axis X, is roughly a quarter of the length of major axis X. Fins **23** and **24** are tangent to the tube **11** and have a thickness equal to the thickness of wall **22** and are provided with respective outer surface **23***a* and **24***a*, which are tangent to outer surface **22***a*, and inner surface **23***b* and **24***b*, which are ideally tangent to the inner surface **22***b*.

Tube **11** is extruded with a longitudinal rib **25** (shown in dotted lines in FIG. **3**) protruding from outer surface **22***a* at the intersection of wall **22** with minor axis Y. Rib **25** has a rectangular cross section and is partially machined to form a number of teeth **26** equally spaced along tube **11** for spacing adjacent turns **17**.

Once extruded with fins **23**, **24** and machined the rib **25**, tube **11** is coiled about axis A**1** to form helix **16**. This operation actually comprises calendering tube **11**, with the minor axis Y of the section of tube **14** maintained substantially parallel to axis A**1**. The relatively small size of fins **23** and **24** does not hinder the calendering operation, and does not call for notching fins **23** and **24**. The three spacers **19** are clamped on the helix **16** and arranged 120 degrees apart, so as to form, with the coiled tube **11**, an assembly which is inserted inside lateral wall **13** of casing **10**. Annular walls **14** and **15** are then fitted to the opposite ends of cylindrical wall **13**.

Tube **11** is coiled with a constant pitch and radius, so that fins **23** and **24** of each turn **17** face and are parallel to fins **23** and **24** of the adjacent turns **17**, as shown in FIG. **2**. A gap is thus formed between each two adjacent turns **17**, is of constant width at fins **23** and **24**. The fumes flow from region B**1** to regions B**3** in direction D**1** towards wall **13**, then flow in direction D**2** between turns **17** and wall **13**, flow between turns **17** in direction D**3** from regions B**3** to region B**2**, and are finally expelled by exhaust pipe **7**. The successive gaps between turns **17** therefore define compulsory fume paths.

The height of rib **25** may be selected to be equal to the most appropriate distance between adjacent turns **17** and their fins **23** and **24**.

In FIG. **4** variation, tube **11** is provided with an additional fin **27** parallel to fins **23** and **24** to axes A**1** and X and located between fins **23** and **24**.

According to FIG. **5** variation, tube **11** is provided with additional fin **27** and additional fin **28** located opposite and coplanar to fin **27**.

In FIG. **6** variation, tube **11** is provided with additional fin **28** only, whereas additional fin **27** is missing.

FIG. **7** variation shows a tube **11** provided with an additional fin **29**, which is coplanar and opposite to fin **23**, and additional fin **30**, which is coplanar and opposite and coplanar to fin **24**.

In FIG. **8** variation, tube **11** is provided with additional fin **29** and **30** tangent to the outer wall **22** of tube **11** and fins **27** and **28**.

Exchanger **4** as described above may also be used in condensation boilers comprising a main exchanger, and in which exchanger **4** provides solely for condensing the fumes, as opposed to acting as a combustion chamber as in the example described.

The invention claimed is:

1. A heat exchanger for a gas boiler for producing hot water; the heat exchanger (**4**) comprising a casing (**13**) extending along a first axis (A**1**) and through which combustion fumes flow; a tube (**11**) along which water flows, and which is housed inside said casing (**13**) and coils about the first axis (A**1**) to form a helix (**16**) comprising a succession of turns (**17**); and deflecting means (**12**) for directing the fumes between successive turns (**17**); said tube (**11**) comprising at least a first and a second fins (**23**, **24**) extending along the length of said tube (**11**) and facing one another; said heat exchanger being characterized in that said first and second fin (**23**, **24**) are tangent to said tube (**11**).

2. A heat exchanger as claimed in claim **1**, characterized in that the first and second fins (**23**, **24**) are continuous with no interruptions.

3. A heat exchanger as claimed in claim **1**, characterized in that the first and second fin (**23**, **24**) are directed outwardly with respect to said first axis (A**1**).

4. A heat exchanger as claimed in claim **1**, characterized in that the first and second fins (**23**, **24**) of each turn (**17**) are parallel to and face the first and second fin (**23**, **24**) respectively of an adjacent turn (**19**).

5. A heat exchanger as claimed in claim **1**, characterized in that said tube (**11**) comprises a third and a fourth fins (**29**, **30**) parallel to each other and facing one another; said third fin (**29**) being coplanar to said first fin (**23**) and said fourth fin (**30**) being coplanar with said second fin (**24**); said third and fourth fins (**29**, **30**) being directed inwardly with respect to said first axis (A**1**).

6. A heat exchanger as claimed in claim **5**, characterized in that said tube (**11**) comprises a fifth fin (**27**) parallel to the first and second fins (**23**, **24**) and located in between the first and the second fins (**23**, **24**) and directed outwardly with respect to the first and second fins (**23**, **24**).

7. A heat exchanger as claimed in claim **6**, characterized in that said tube (**11**) comprises a sixth fin (**28**) parallel to the first and the second fin (**23**, **24**) and located between the first and second fin (**23**, **24**) on the opposite side of the first and second fins (**23**, **24**).

8. A heat exchanger as claimed in claim **1**, characterized in that said tube (**11**) is provided with wall (**22**) having an oval cross section with a major axis (X) parallel to the first and second fin (**23**, **24**), and a minor axis (Y) perpendicular to the first and second fin (**23**, **24**).

9. A heat exchanger as claimed in claim **1**, characterized by comprising spacers (**19**) for keeping said helix (**16**) a given distance apart from the casing (**10**) of the heat exchanger (**4**).

10. A heat exchanger as claimed in claim **1**, characterized in that the tube (**11**) is provided with integrally made teeth (**26**) for spacing said turns (**17**) apart.

11. A method of producing the heat exchanger (**4**) claimed in claim **7**, characterized by extruding said tube (**11**) and the first (**23**) and second (**24**) fins to form a straight, finned tube (**14**) in one extrusion operation.

12. A method as claimed in claim **11**, characterized by extruding said tube (**11**) in one extrusion operation with said third and fourth fins (**29**, **30**).

13. A method as claimed in claim **11**, characterized by extruding said tube (**11**) with said fifth fin (**27**) in one extrusion operation.

14. A method as claimed in claim **11**, characterized by extruding said tube (**11**) with said sixth fin (**28**) on one extrusion operation.

15. A method as claimed in claim **11**, characterized by extruding said tube (**11**) with a continuous substantially radial rib (**25**) and partially machining said rib (**25**) so as to make teeth (**26**) for spacing said turns (**17**) apart once the tube (**11**) is coiled in a helix (**16**).

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